

A Conceptual Framework for Network Centric Operations

**Network Centric Warfare Europe
4 June 2003**



**Office of Force Transformation
Office of the Secretary of Defense**

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Topic Areas

- ***Why a Conceptual Framework (CF)***
- ***The NCW/NCO CF***
- ***Applying the Framework***
- ***Collaboration Opportunities***

OFT Goals

- **Make force transformation a pivotal element of national defense strategy and DoD corporate strategy effectively supporting the four strategic pillars of national military strategy.**
- **Change the force and its culture from the bottom up through the use of experimentation, transformational articles (operational prototyping) and the creation and sharing of new knowledge and experiences.**
- **Implement Network Centric Warfare (NCW) as the theory of war for the information age and the organizing principle for national military planning and joint concepts, capabilities, and systems.**
- **Get the decision rules and metrics right and cause them to be applied enterprise wide.**
- **Discover, create or cause to be created new military capabilities to broaden the capabilities base and mitigate risk.**

Get the Theory Right

- Objective:
 - Develop and refine NCW as the Theory of War for the Information Age
- Desired End State:
 - A recognized body of knowledge that describes:
 - NCW Theory
 - Key variables and relationship between variables
 - Attributes and metrics for measuring the variables
 - Principles of War
 - Revised - upgraded as required
 - Theory of War for Information Age
 - Nature
 - Character
 - Conduct

***Focus of
NCW
Conceptual
Framework
Initiative***

Why a CF - Get NCW Theory Right

- Develop a Conceptual Framework for Network Centric Warfare
 - Parallels approach taken in Business Schools to describe value and impact of Information Technology
 - Describes Theory in terms of Variables and Relationships
 - Creates the “lens to view” and “mental model” to comprehend
- Develop Case Studies & Applications that apply the Conceptual Framework
 - Builds on strong academic tradition of employing case studies as a mechanism for ***transmitting knowledge***
 - Describes how new source of power (information sharing) is developed and leveraged to create competitive advantage

Why a CF - Warfighting Advantage

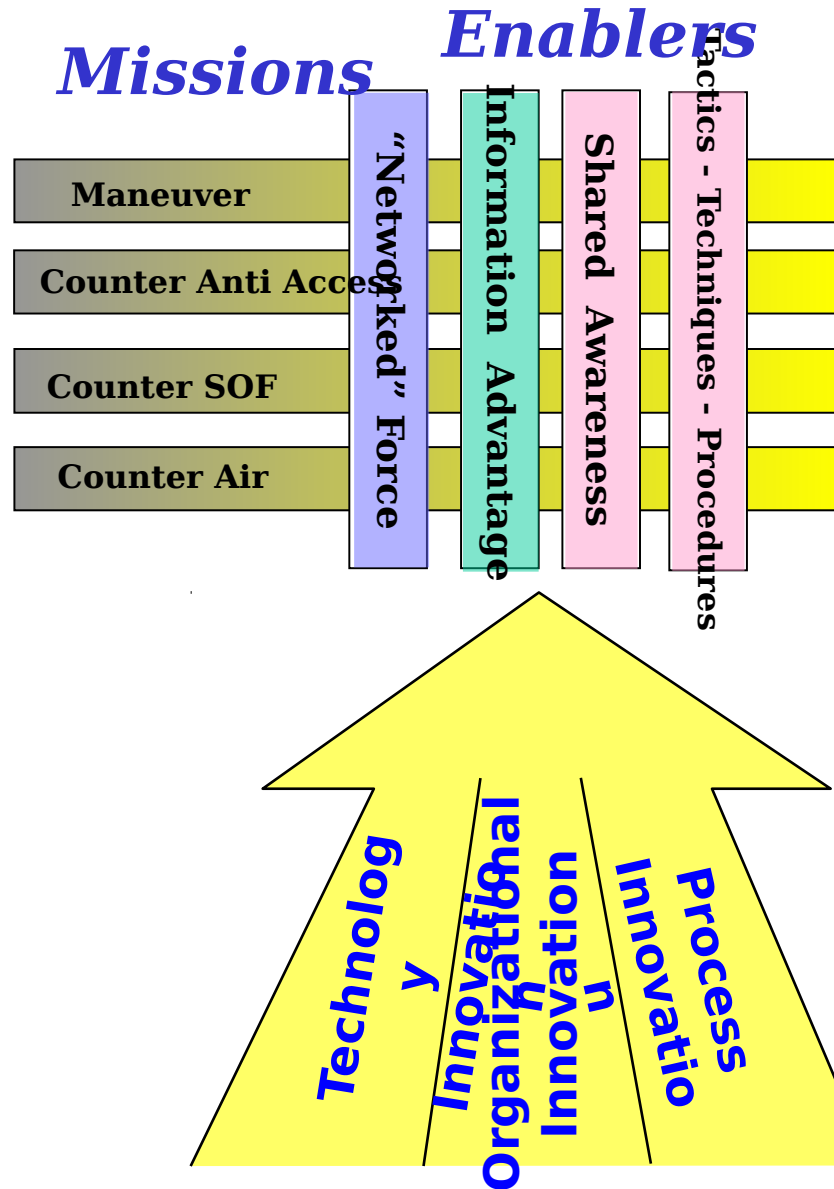
***Networked Forces
Outfight***

***Non-
Networked Forces***

Warfighting Advantage: Evidence

- **Dominant Maneuver**
 - Digitized forces demonstrate capability to fight over a much larger area with **fewer forces** than non-digitized forces (USA Division Capstone Exercise - Phase I, Apr 2001)
- **Precision Engagement - Counter Anti Access**
 - Networked combined force requires **62% less time** to restore mine free shipping in Strait of Hormuz (FBE Foxtrot, Dec 1999)
- **Precision Engagement - Counter SOF (CSOF)**
 - Decision cycle reduced by half - shooter effectiveness increased
 - **10 fold reduction** in SOF penetrators by water (FBE Delta, Oct 1998)
- **Full Dimensional Protection - Counter Air**
 - USAF found F-15Cs, working with data links (shared awareness), **increased kill ratio by over 100% -- 2.6:1** for both Day & Night Ops (JTIDS Operational Special Project - Mid 1990's)

Understanding the Evidence for Warfighting Advantage

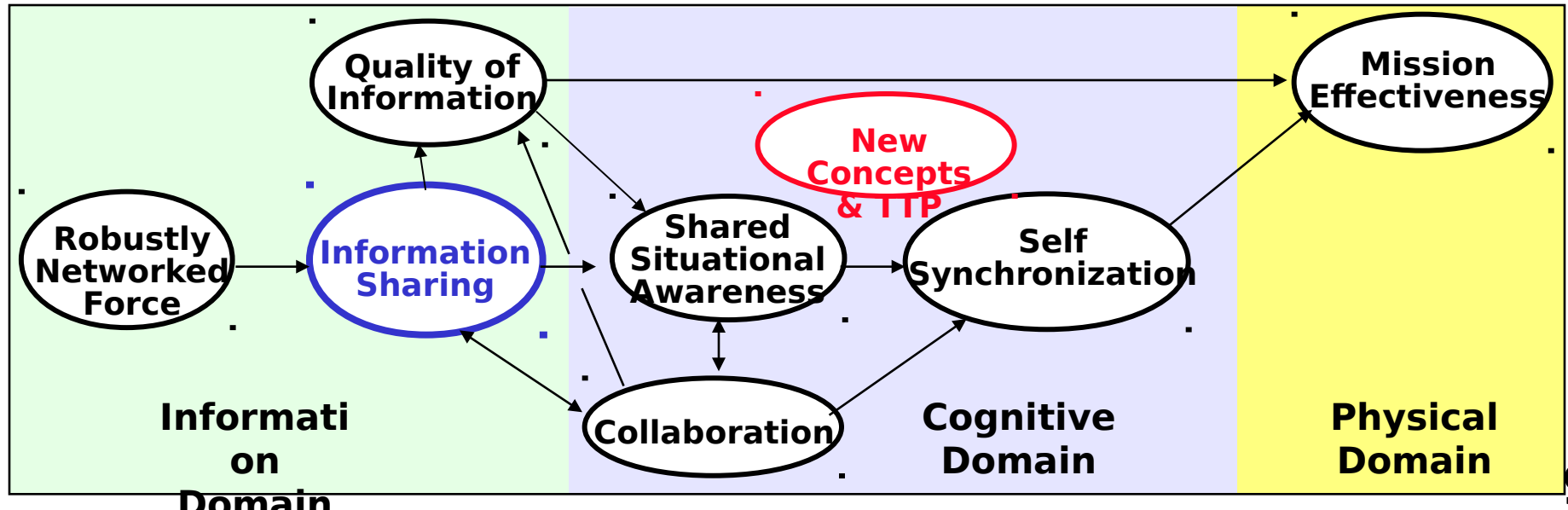


Why a CF - Sources of Power

Tenets of NCW: A Hypothesis Regarding Sources of Power

- A robustly networked force improves information sharing
- Information sharing and collaboration enhances the quality of information and shared situational awareness
- Shared situational awareness enables collaboration and self synchronization, and enhances sustainability and speed of command
- These in turn dramatically increase mission effectiveness

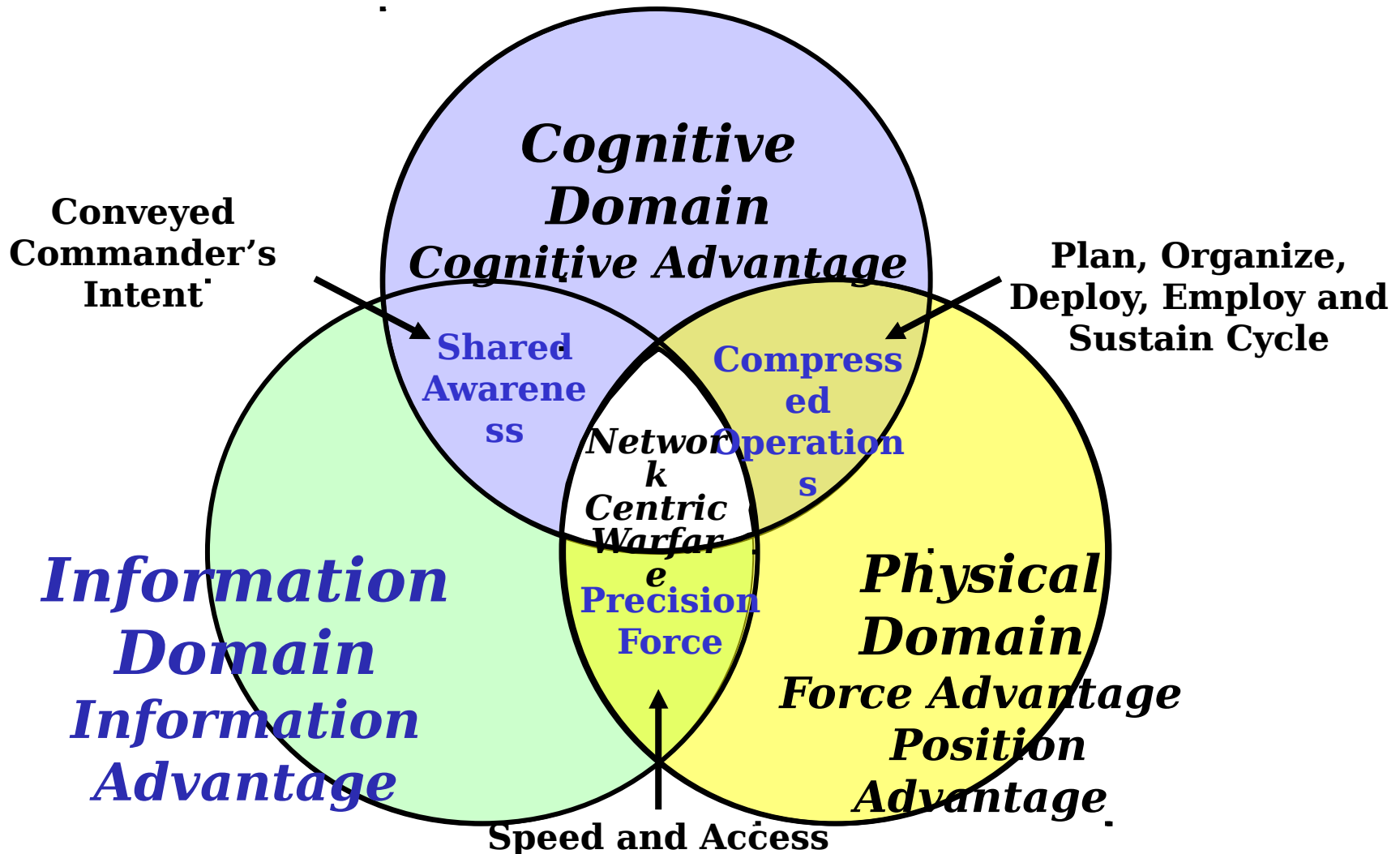
Top Level Measures for Exploring NCW Hypothesis



Information-Age Warfare

Domains of conflict

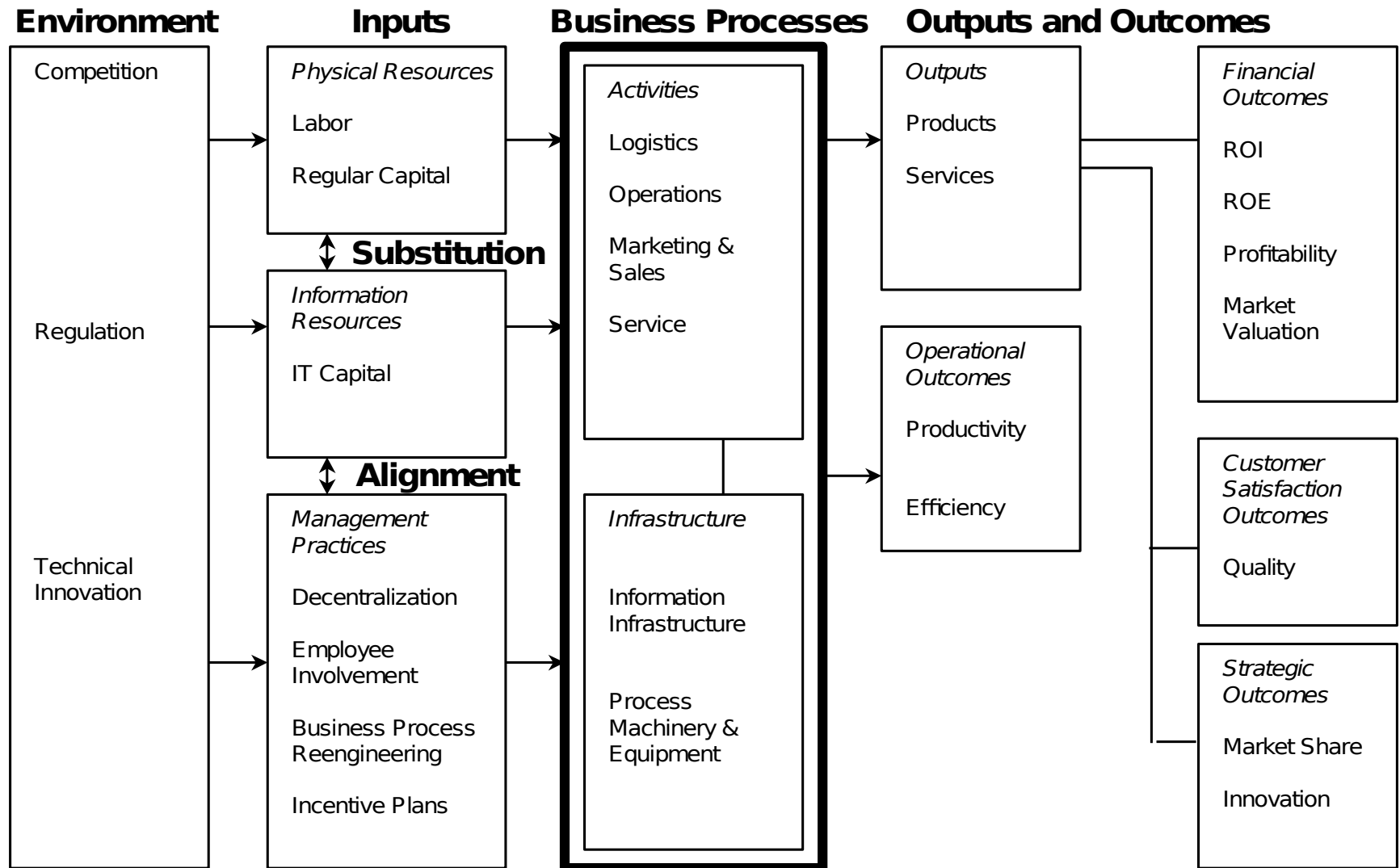
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Topic Areas

- ***Why a Conceptual Framework (CF)***
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- ***Applying the Framework***
- ***Collaboration Opportunities***

Example Conceptual Framework for IT Value Creation



Evolution of the NCW Conceptual Framework

Tenets of NCW: DoD Report to Congress on NCW (2001)

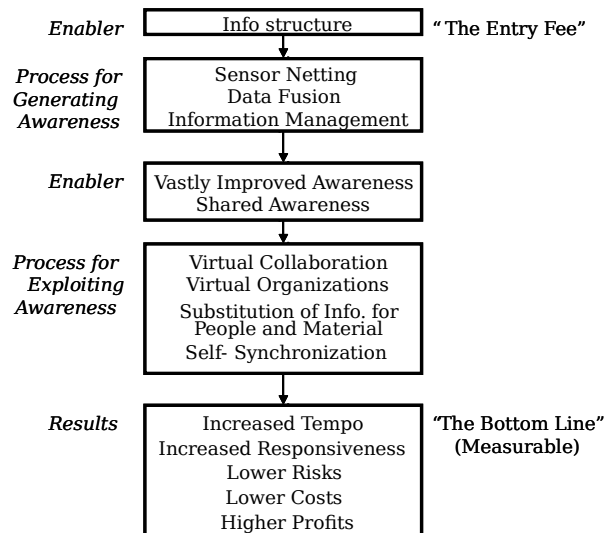
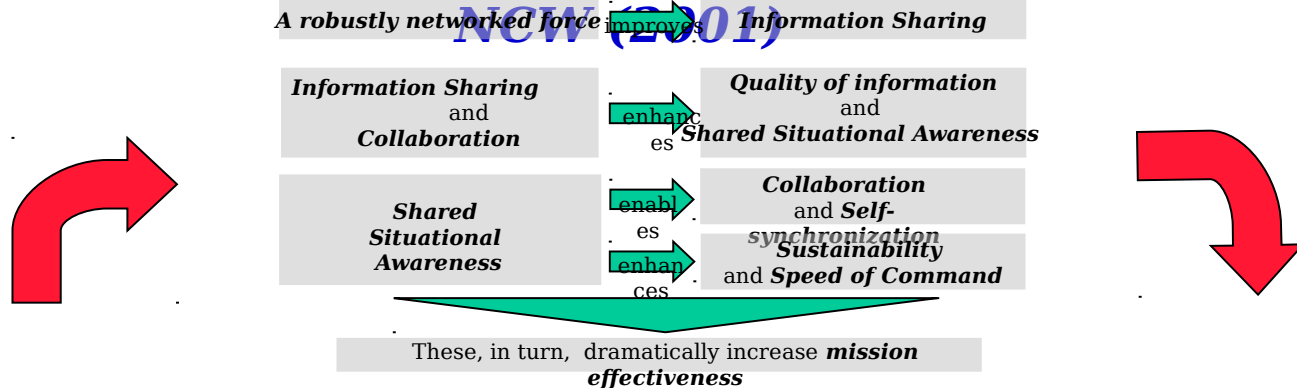
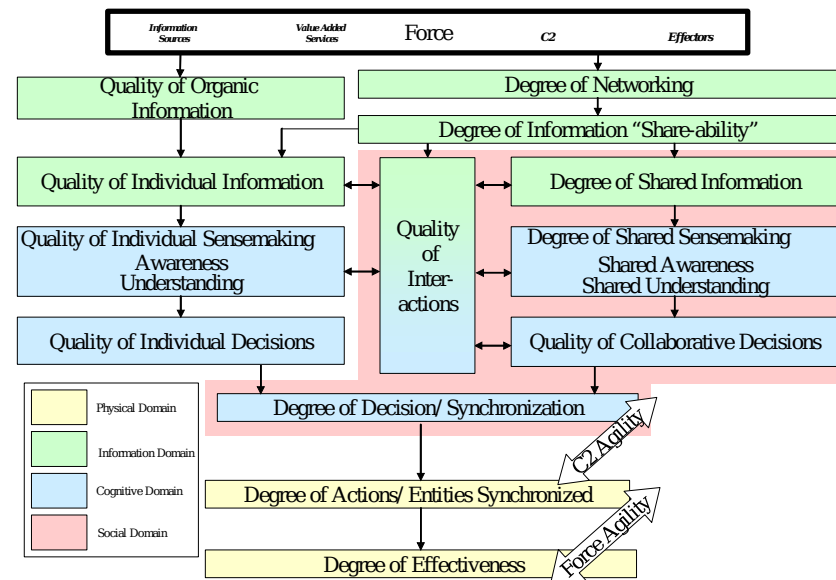


Figure 6. The NetworkCentric Enterprise

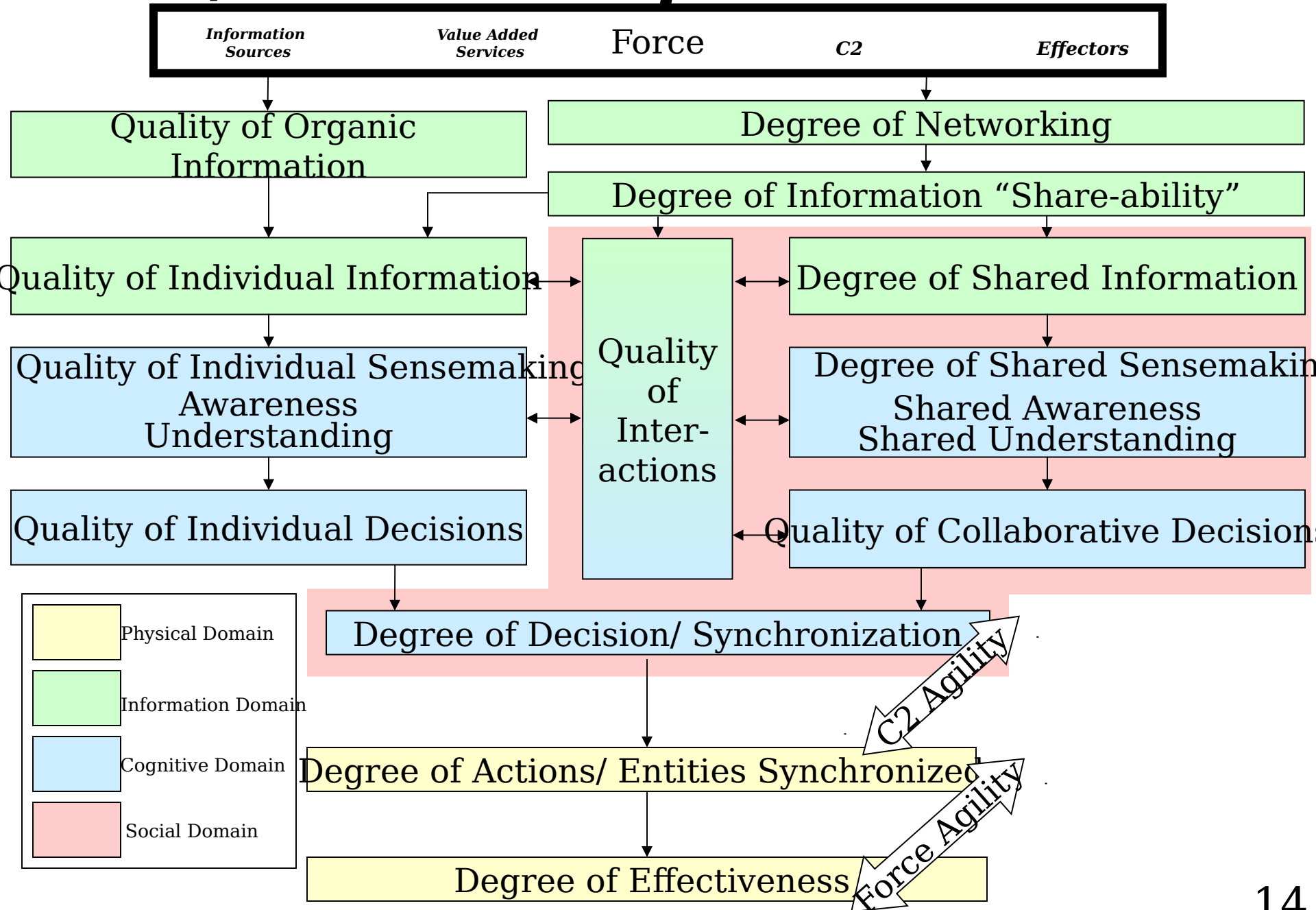
NCW Foundation (1999)

P 36, Network Centric Warfare: Developing and Leveraging Information Superiority. CCRP. 1999



NCW Conceptual Framework (2003)

NCW/NCO Conceptual Framework



Domains

Physical Domain

where strike, protect, and maneuver take place across different environments

Information Domain

where information is created, manipulated and shared

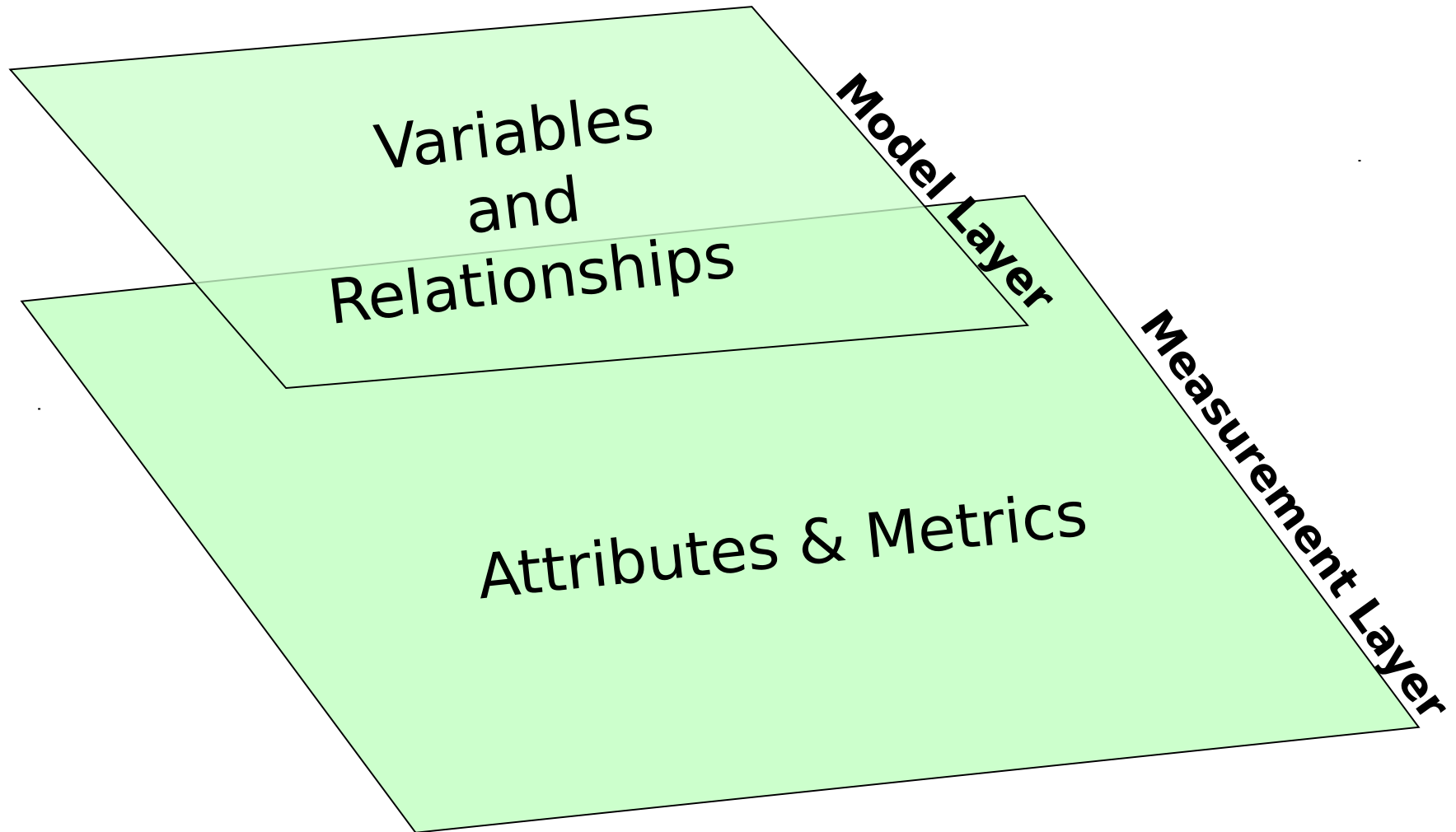
Cognitive Domain

where perceptions, awareness, beliefs, and values reside and where, as a result of sensemaking, decisions are made

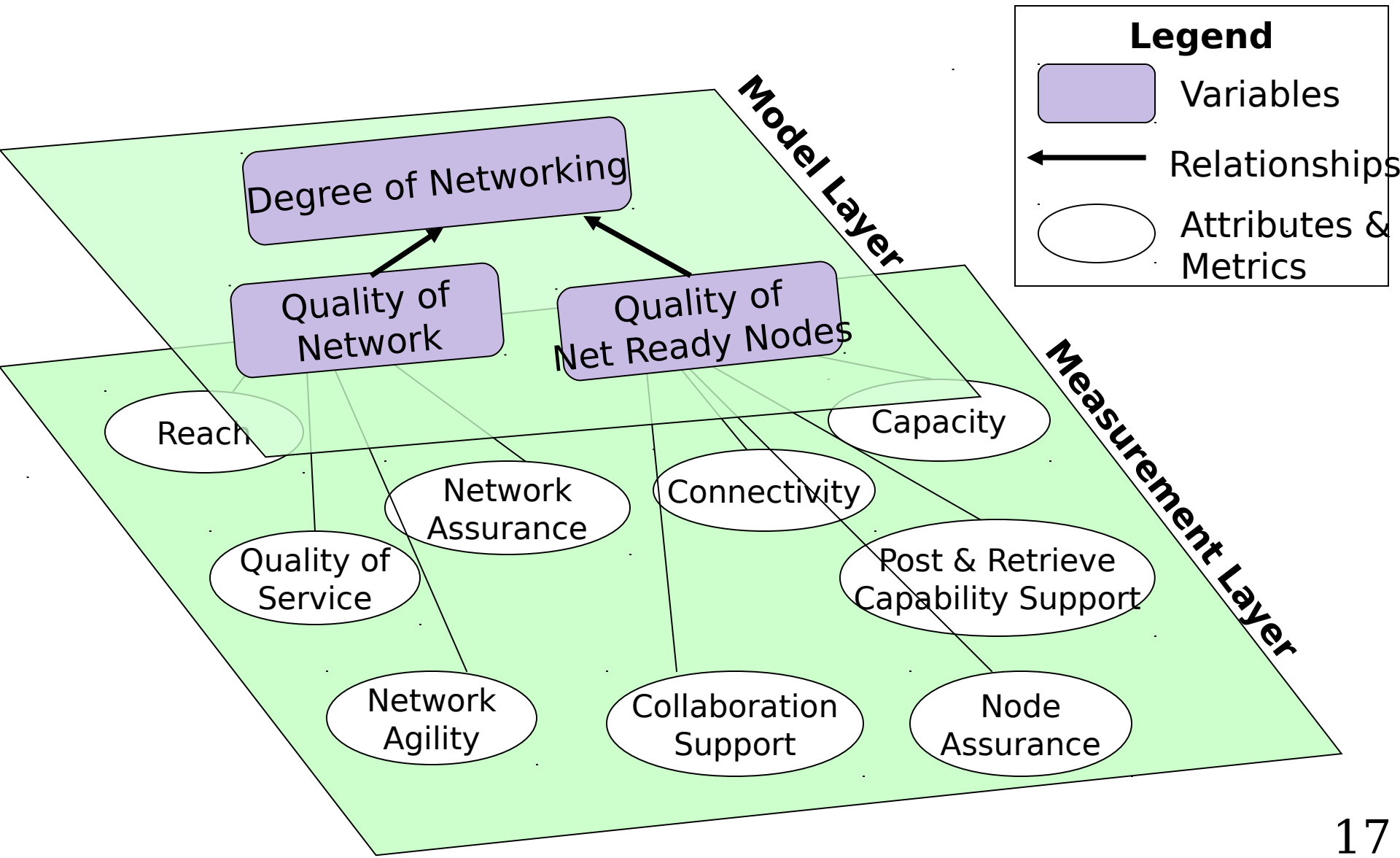
Social Domain

where force entities interact

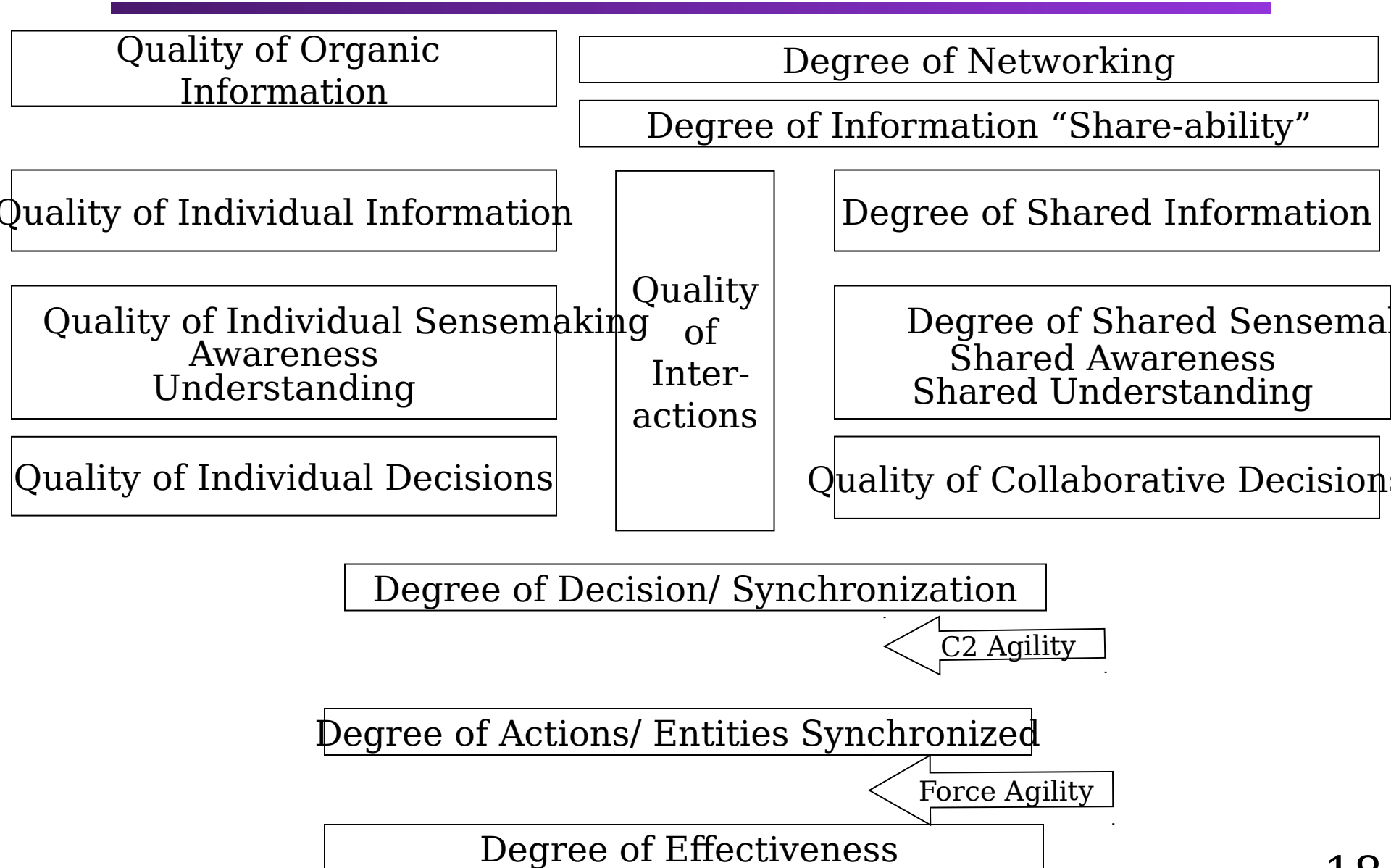
Levels of NCW Conceptual Framework



Structure of NCW Conceptual Framework

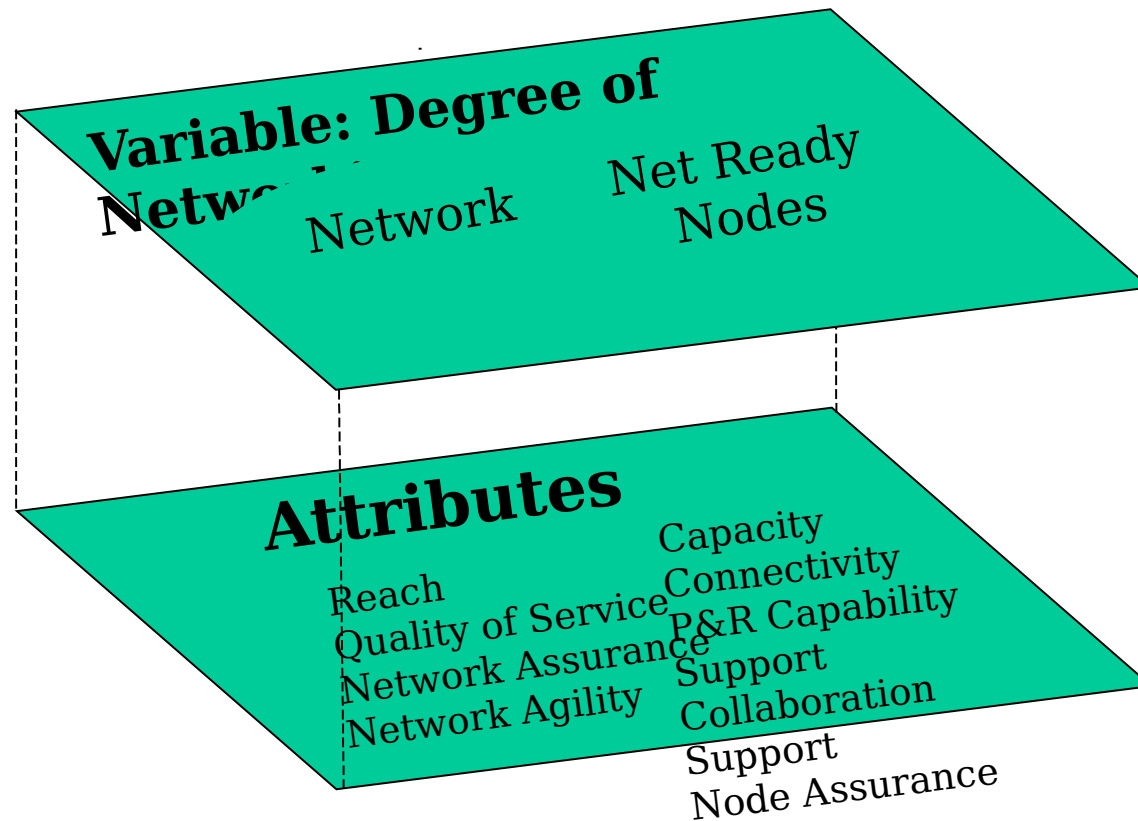


Variables



NCW Attributes

Each Variable is Evaluated by a Vector of Attributes

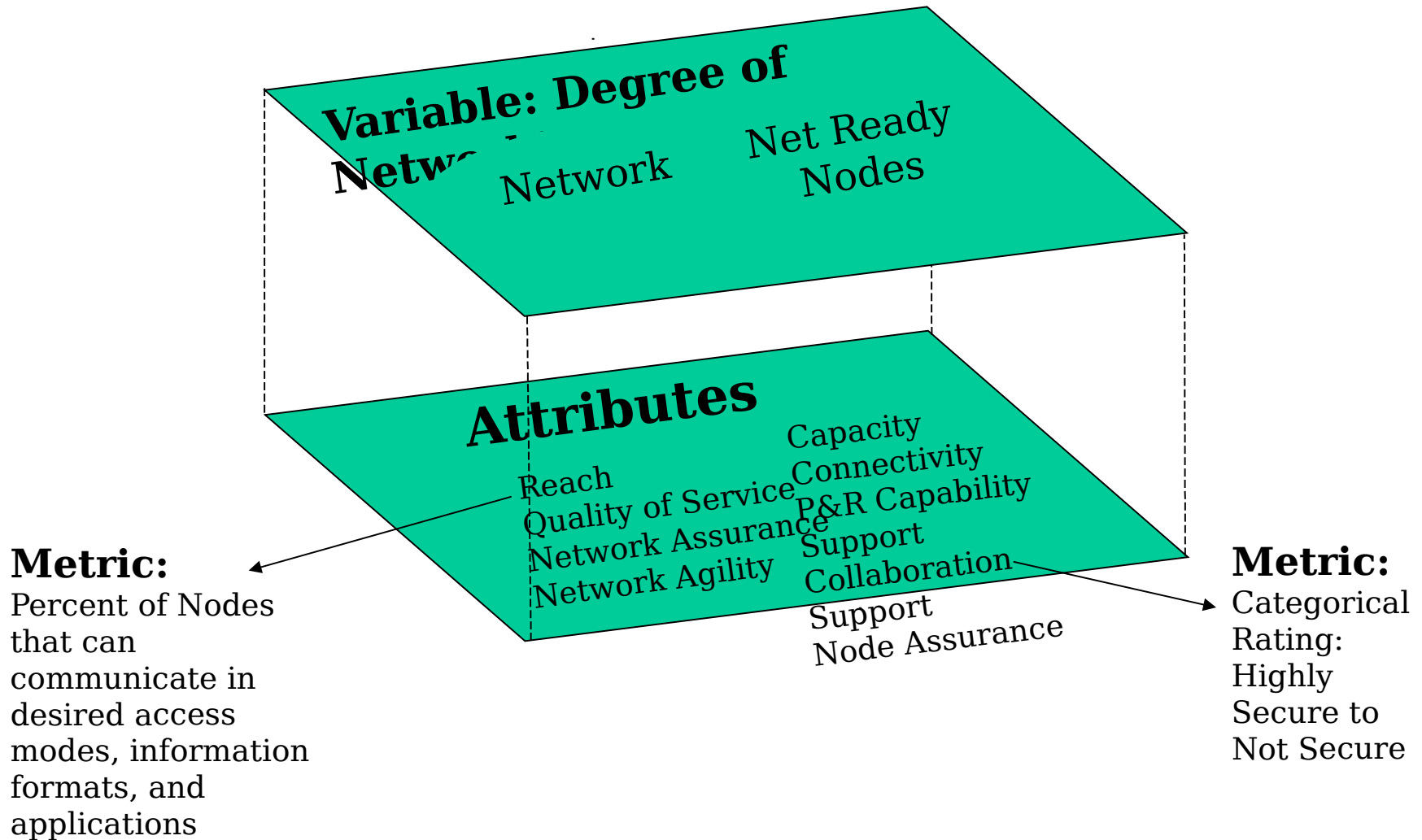


Classes of Attributes

- Objective Attributes measure quality in reference to criteria that are independent of the situation
 - Correctness
 - Consistency
 - Currency
 - Precision
 - Extent of Sharing
- Fitness for Use Attributes measure quality in reference to criteria that are determined by the situation
 - Completeness
 - Accuracy
 - Relevance
 - Timeliness
- Agility Attributes measure quality of implementation
 - Robustness
 - Responsiveness
 - Flexibility
 - Innovativeness
 - Adaptiveness
- Other Attributes unique to specific variables
 - Uncertainty
 - Mode of decision making
 - Etc.

NCW Metrics

Each Attribute is Measured by a Specific Metric

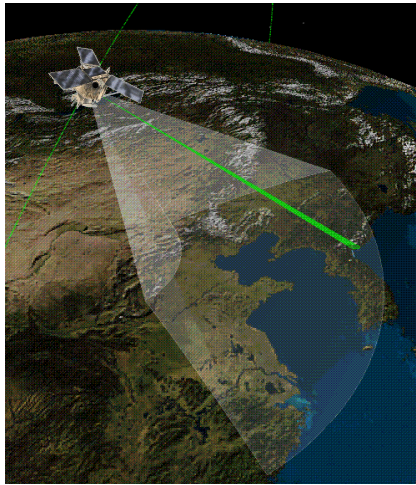


Innovations of NCW Framework

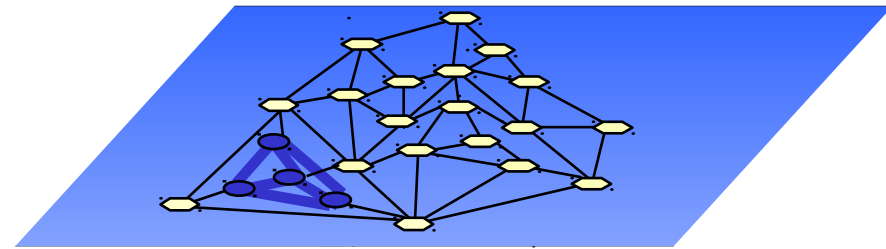
- Identifies key variables in NCW value chain
- Explicitly incorporates the Social Domain into the framework
- “Top Level” conceptual framework links the force, key variables, and outcomes and illustrates the role of the physical, information, cognitive and social domains
- Each variable is evaluated by a vector of attributes
- Important “classes of attributes” are identified
- Each attribute is measured with a specific metric

Force

Key Elements: Nodes and Networks



Sensors



Networks

Command & Control



People

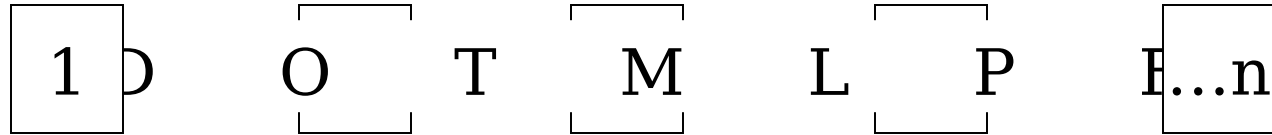
Effectors (Shooters)



Force

Measures for Key Elements

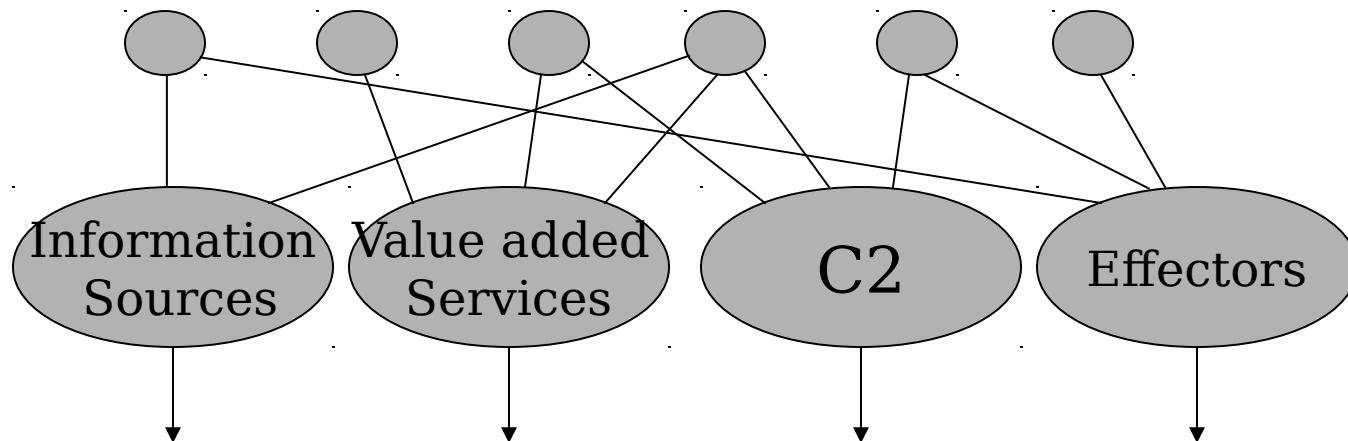
Mission
Capability
Packages



Elements
(Network,
Nodes)

People, Platforms, Facilities, Units, Networks, ...

Roles/
Functions



Measures
(Exogenous
to the NCW
framework)

- Phenomenology
- Coverage
- Persistence
- Performance
- Agility
- Service
- Capability
- Capacity
- Quality of Service
- Agility

Embedded in
the NCW
conceptual
framework

- Effects
- Coverage
- Persistence
- Survivability
- Agility

NCW Conceptual Framework: Summary of Attributes (1)

Force

Information Sources

Value Added Services

C2

Effectors

Quality of Organic Information

Objective Measures

Correctness

Consistency

Currency

Precision

Fitness for Use

Completeness

Accuracy

Relevance

Timeliness

Degree of Networking

Network

Reach

Quality of Service

Network Assurance

Network Agility

Net Ready Nodes

Capacity

Connectivity

P&R Capability Support

Collaboration Support

Node Assurance

Quality of Individual Information

Objective Measures

Correctness

Consistency

Currency

Precision

Fitness for Use

Completeness

Accuracy

Relevance

Timeliness

**Nature
and
Quality
of
Interactions**

Degree of Information "Share-ability"

Quantity of Posted Info

Quantity of Retrievable Info

Ease of Use

NCW Conceptual Framework: Summary of Attributes (2)

Degree of Information "Share-ability"

Ease of Use

Quantity of Posted Info

Quantity of Retrievable Info

Quality of Individual Information

Objective Measures

Correctness

Consistency

Currency

Precision

Fitness for Use

Completeness

Accuracy

Relevance

Timeliness

Quality of Individual Sensemaking: Awareness

Objective Measures

Correctness

Consistency

Currency

Precision

Fitness for Use

Completeness

Accuracy

Relevance

Timeliness

Uncertainty

Quality of Interactions

Characteristics of Interaction

Depth

Quantity

Quality

Breadth

Reach

Selectivity

Intensity

Continuity

Latency

Synchronicity

Mode

Agility

Robustness

Flexible

Response

Innovative

Adaptability

Individual Characteristics

Risk Prop

Competence

Trust

Org. Ident

Confidence

Organizational Characteristics

Risk Prop

Competence

Trust

Confidence

Size

Hardness

Diversity

Permanence

Autonomy

Structure

Interdependence

Organizational Behavior

Cooperation

Efficiency

Synchronization

Engagement

T vs. T

Degree of Shared Information

Objective Measures

Extent

Quality

Correctness

Consistency

Currency

Precision

Completeness

Accuracy

Relevance

Timeliness

Degree of Shared Sensemaking: Shared Awareness

Objective Measures

Extent

Quality

Correctness

Consistency

Currency

Precision

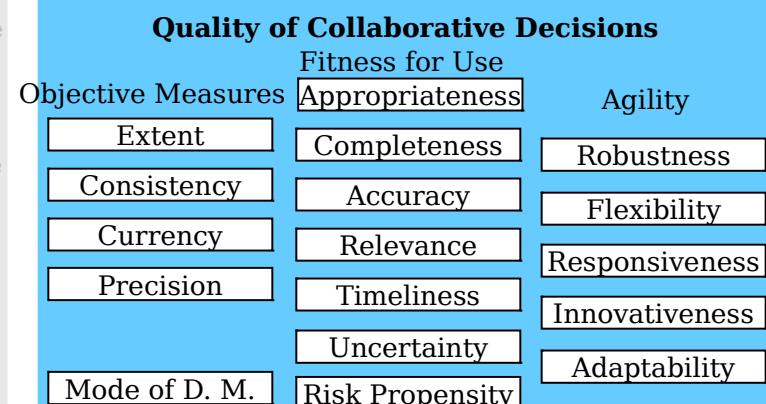
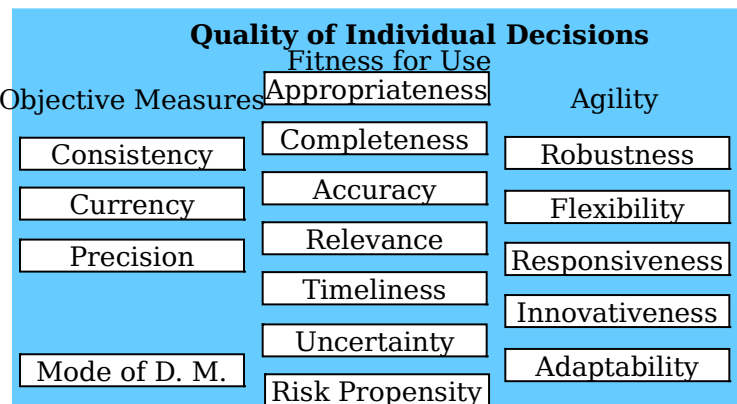
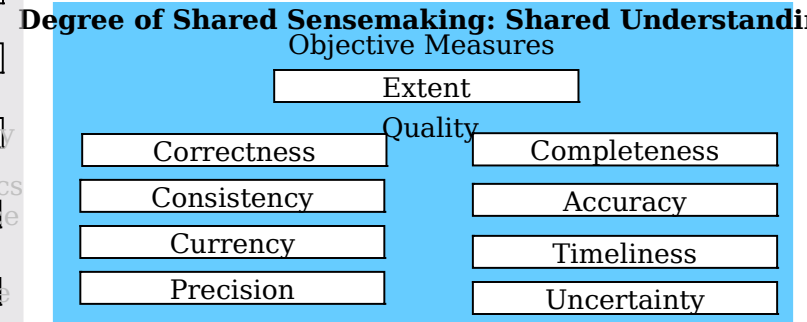
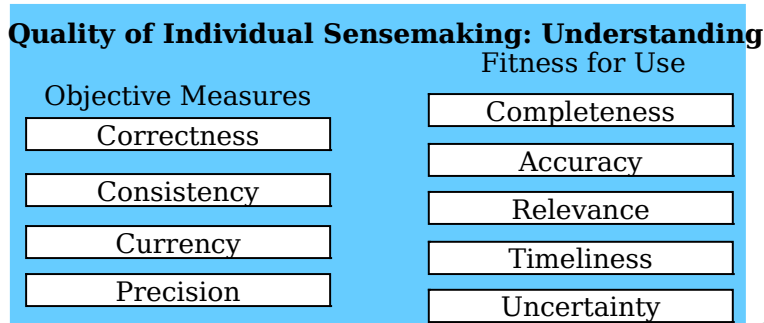
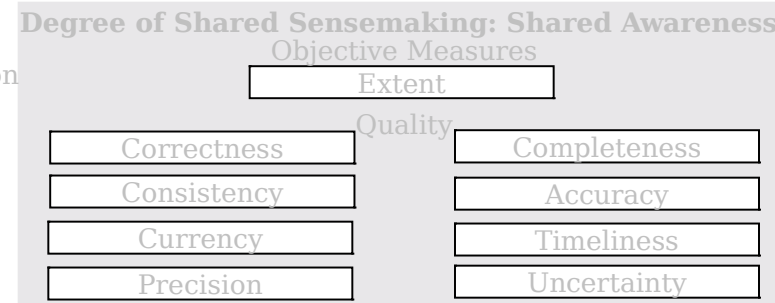
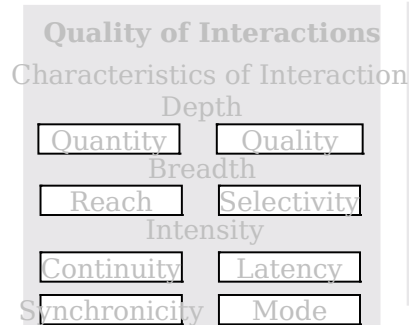
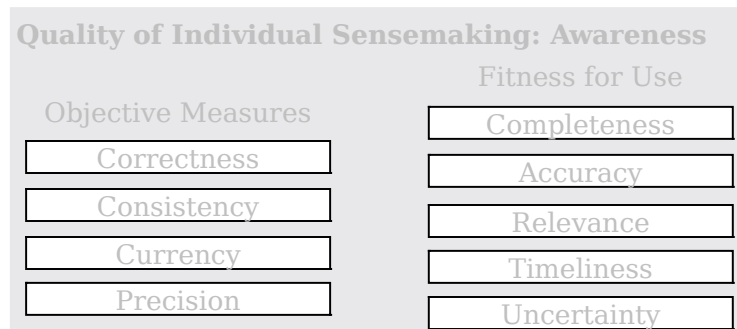
Completeness

Accuracy

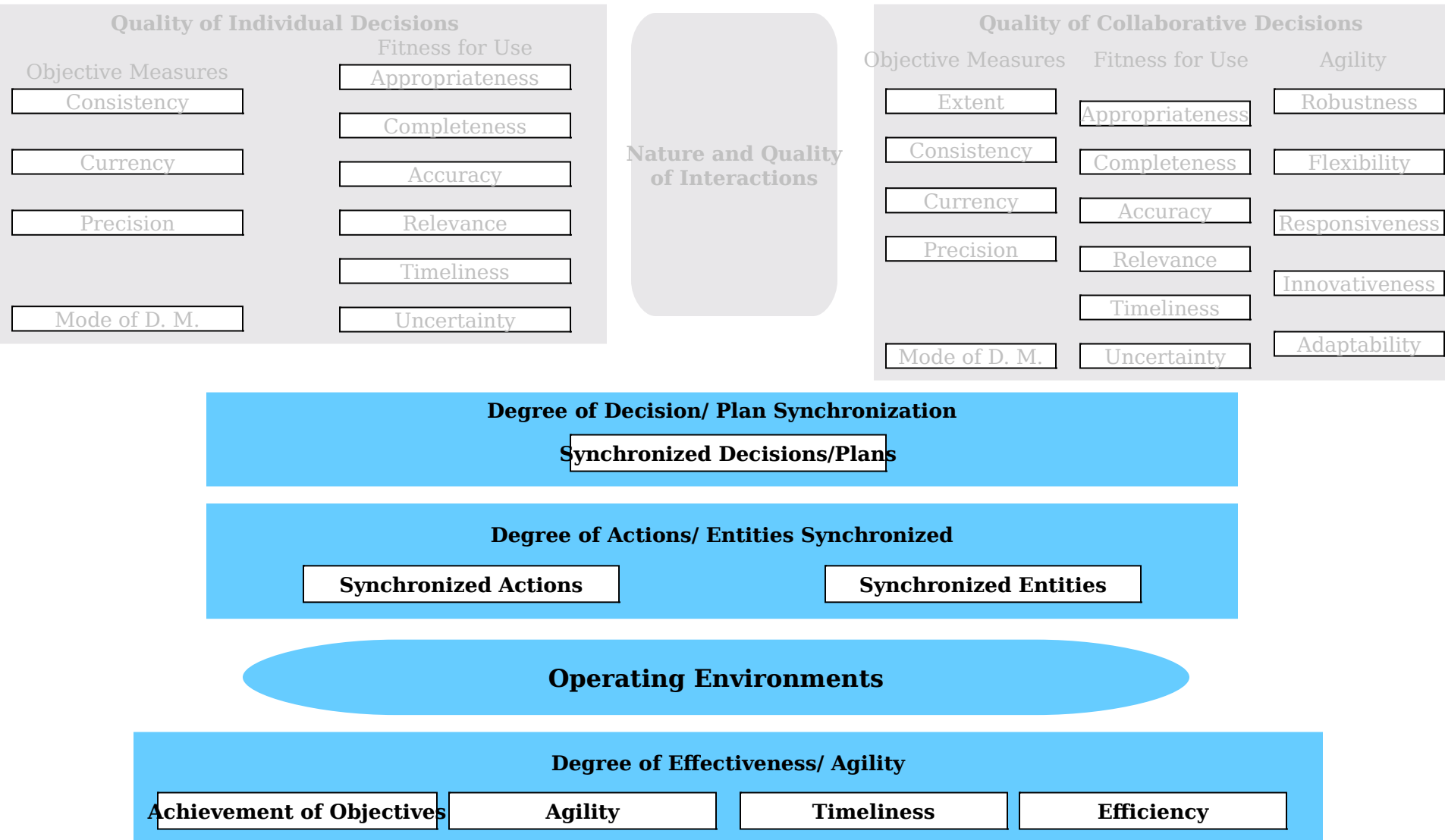
Timeliness

Uncertainty

NCW Conceptual Framework: Summary of Attributes (3)



NCW Conceptual Framework: Summary of Attributes (4)



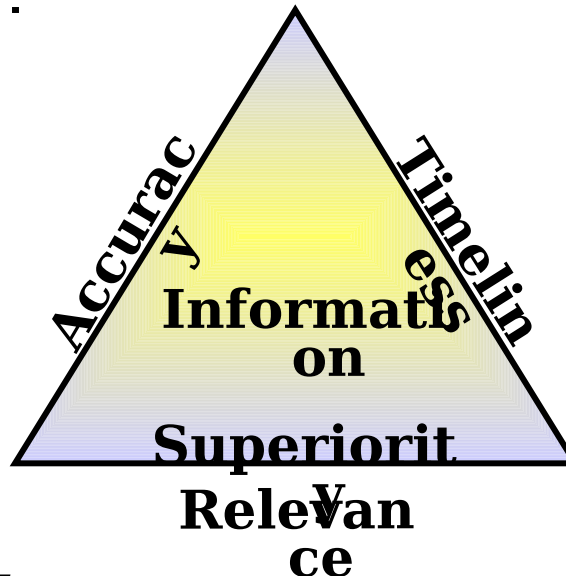
Topic Areas

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- ***The NCW/NCO CF***
- ***Applying the Framework***
- ***Collaboration Opportunities***

Applying the Conceptual Framework

- **Case Studies: Refining the “Theory”**
 - Backward Looking
 - Explanatory in Nature: “Where did the combat power come from?”
- **Applications: Applying the “Theory” to help solve real world problems**
 - Resource allocation:
 - Making the Business case for investments that accelerate the implementation of NCW
 - Requirements Definition
 - Improving capabilities for defining requirements for network-centric solutions
 - Improving Interoperability
 - Experimentation
 - Planning, executing, and evaluating data collected from experiments

CF Applied - “Quantifying” Information Advantage / Superiority



...relative to an adversary...



CF Applied - Information Advantage: Meeting Information Needs



***C/AOC
C/JFACC***

**Individual/
Node**

**Unit/
Flight**

**Force/
Operational Level**

Info On:

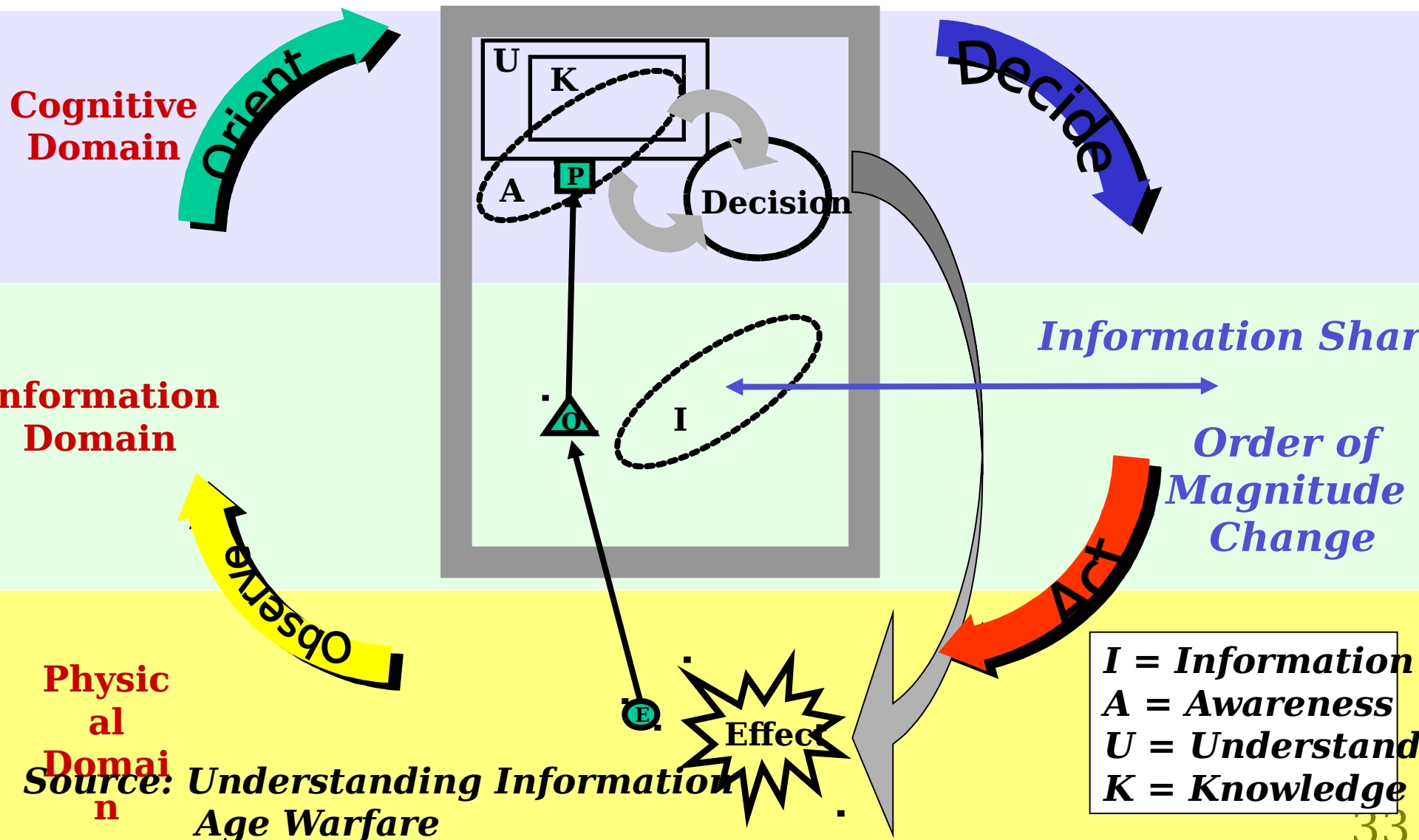
**Friendly
Force**

**Neutrals /
Non
Combatants**

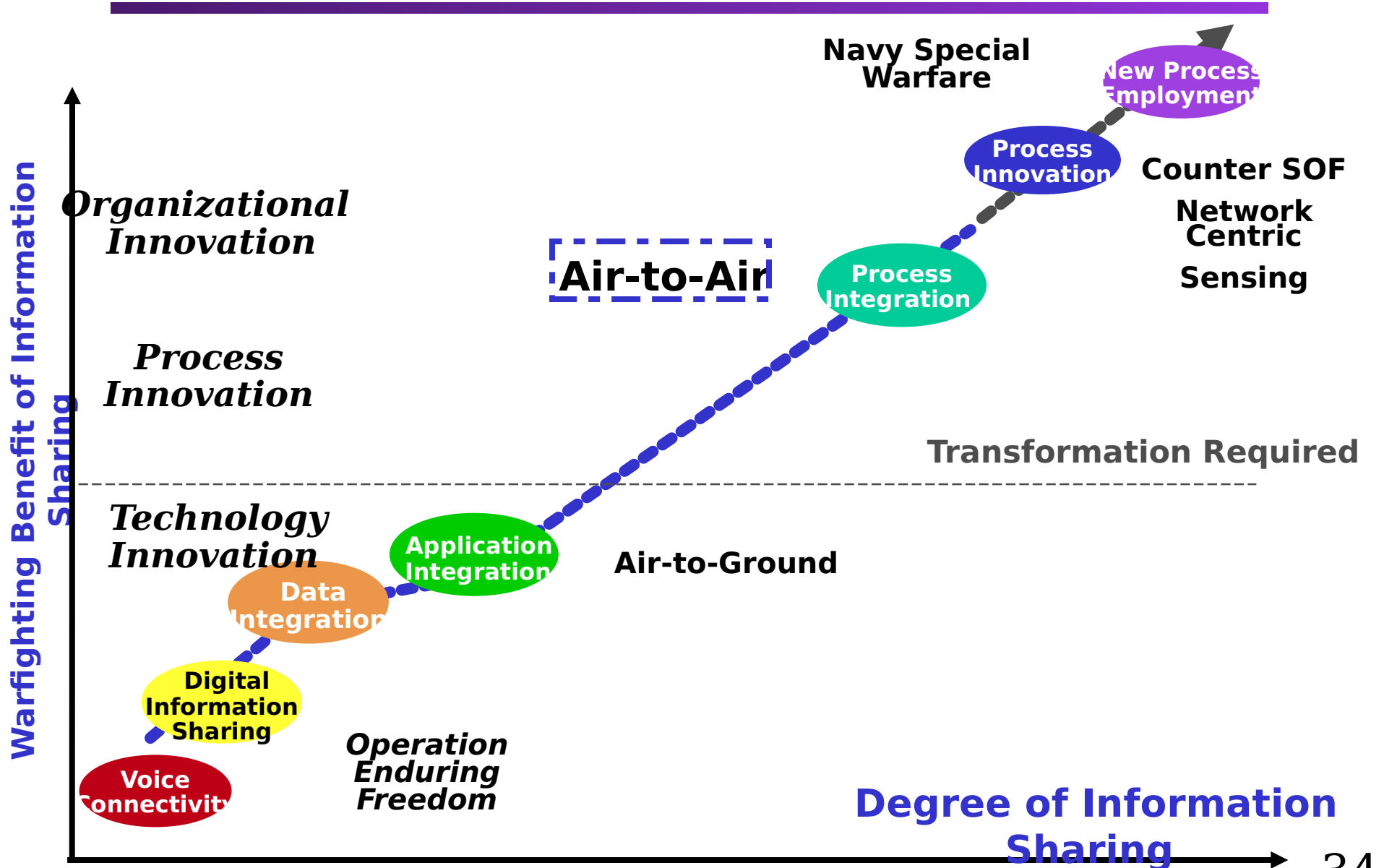
**Aggressor
Force**

Where am I? Where are my buddies? What is CDR's Intent?	Where is the Flight? What is its Disposition? What is CDR's Intent?	Where is the Force? What is its Disposition? Does CDR's intent need to change?
Where are the Airliners?	Where are the Airliners?	Is there commercial Air traffic in the area?
Where is the Adversary?	Where is the Adversary?	How is the Adversary Reacting? Is this what was expected?

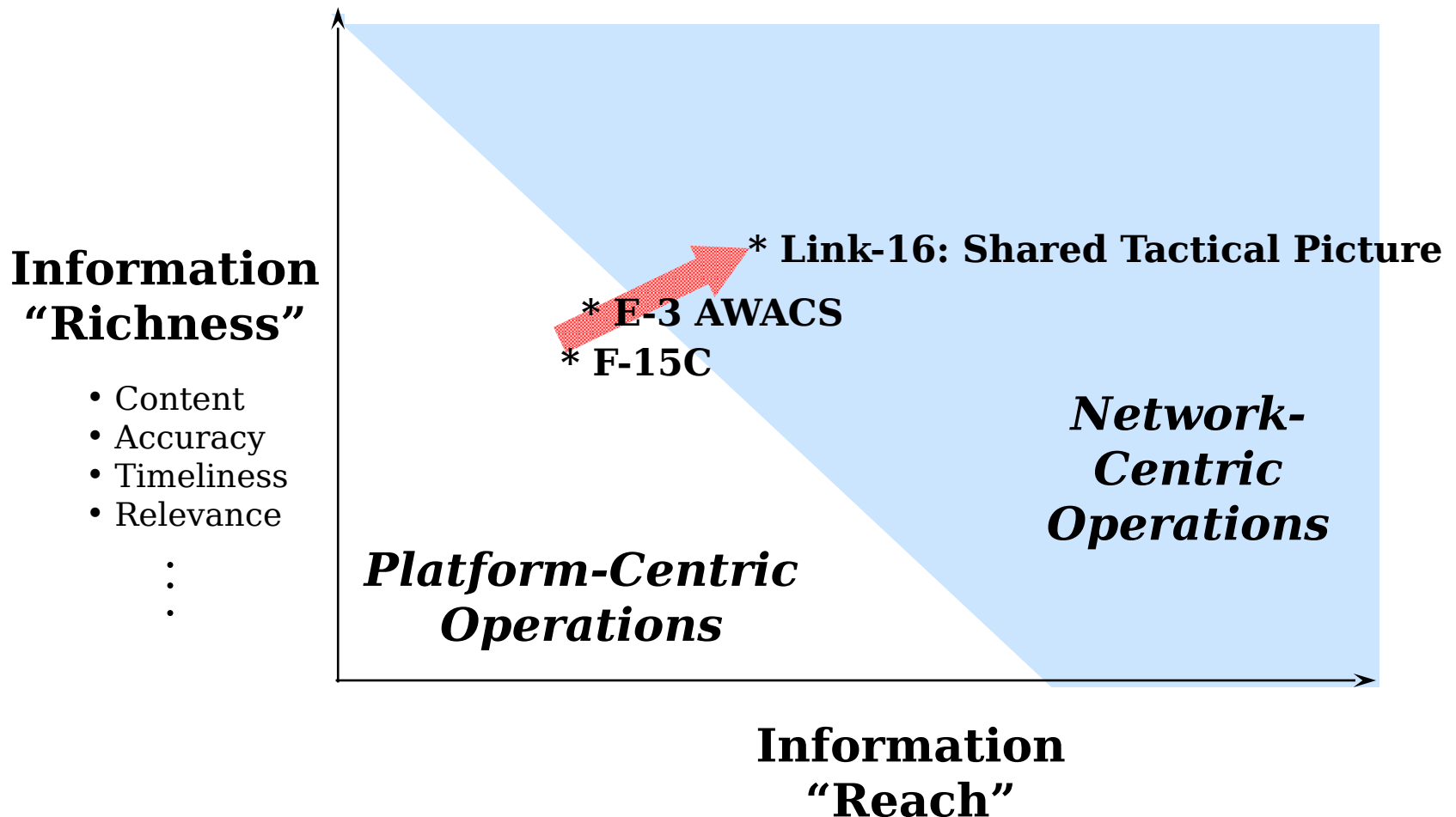
Meeting Decision Maker's Information Needs: “Observe-Orient-Decide-Act” Loop



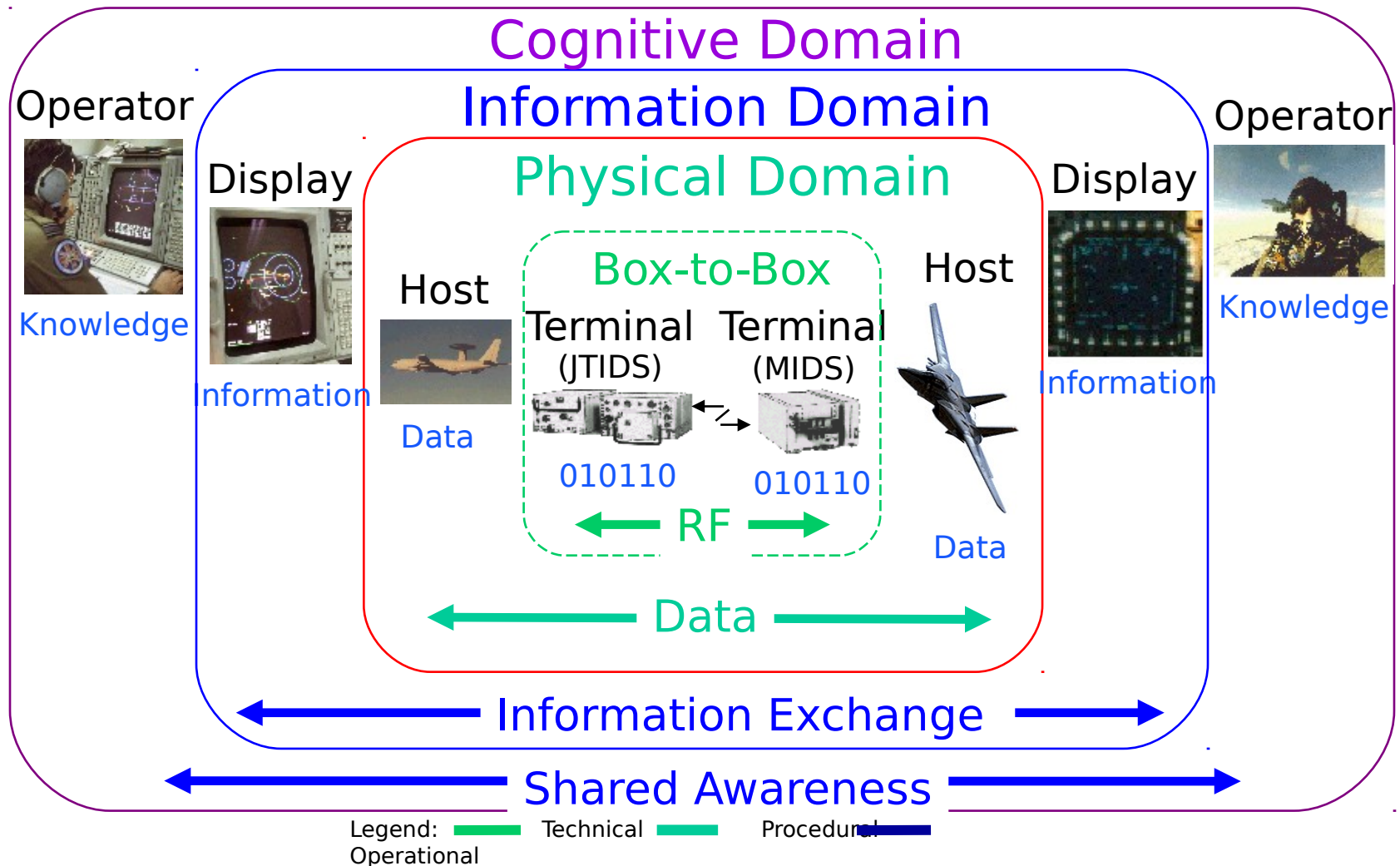
Benefit of Information Sharing: Air-to-Air



Air Superiority Mission: Shared Tactical Picture + Integrated Processes



Air-to-Air Combat: Domain Overlay



Air-to-Air Case Study: The Evidence

F15-C Air Ops: Active Missile Counter Tactics

Without JTIDS/With JTIDS

• Information Advantage
Tactical Picture

Voice Only vs. Shared

• OODA Loop
Self-Synchronization

Baseline Compressed with

• Kill Ratio
x increase) - Day

3.10:1 vs. 8.11:1 (**2.61**

increase) - Night

3.62:1 vs. 9.40:1 (**2.59 x**

• The Bottom Line: ~~Human Battle of Wits~~ ~~plus Flying hours~~ ~~networked~~

~~10,000 demonstrated capability for~~ ~~5,000~~ ~~aircrews fighting with~~

• ~~shared situational~~ ~~increase combat power by~~

2 vs. 2 to 8 vs. 16 ~~awareness to~~

~~over 100%~~

Source: JTIDS Operational Special Project - Report to Congress

(JTIDS - Joint Tactical Information Distribution System) 37

Force

**Mission
Capability
Packages**

Voice Only
(MCP #1)

Voice + Link 1
(MCP #2)

**Elements
(Network
Nodes)**

AWACS

Voice Network

Data + Network

Air Craft

Roles

Information
Sources

Value added
Services

C2

Effectors

Functions

- Detect/
ID
targets

- Fuse data
- ID info
- Distribute
Info.

- Assign
aircraft to
targets
- Coordinate
engagements

- Kill Targets

**Relevant
Attributes**

- Coverage
- Persistence
- Performance

- Capability
- Capacity
- Quality of Service

Embedded in
the NCW
conceptual
framework

- Target Destruction

Quality of Organic Information

Force

Information Sources

Value Added Services

C2

Effectors

Quality of Organic Information

Objective Measures

Correctness

Consistency

Currency

Precision

Fitness for Use

Completeness

Accuracy

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Degree of Networking

Network

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Node Assurance

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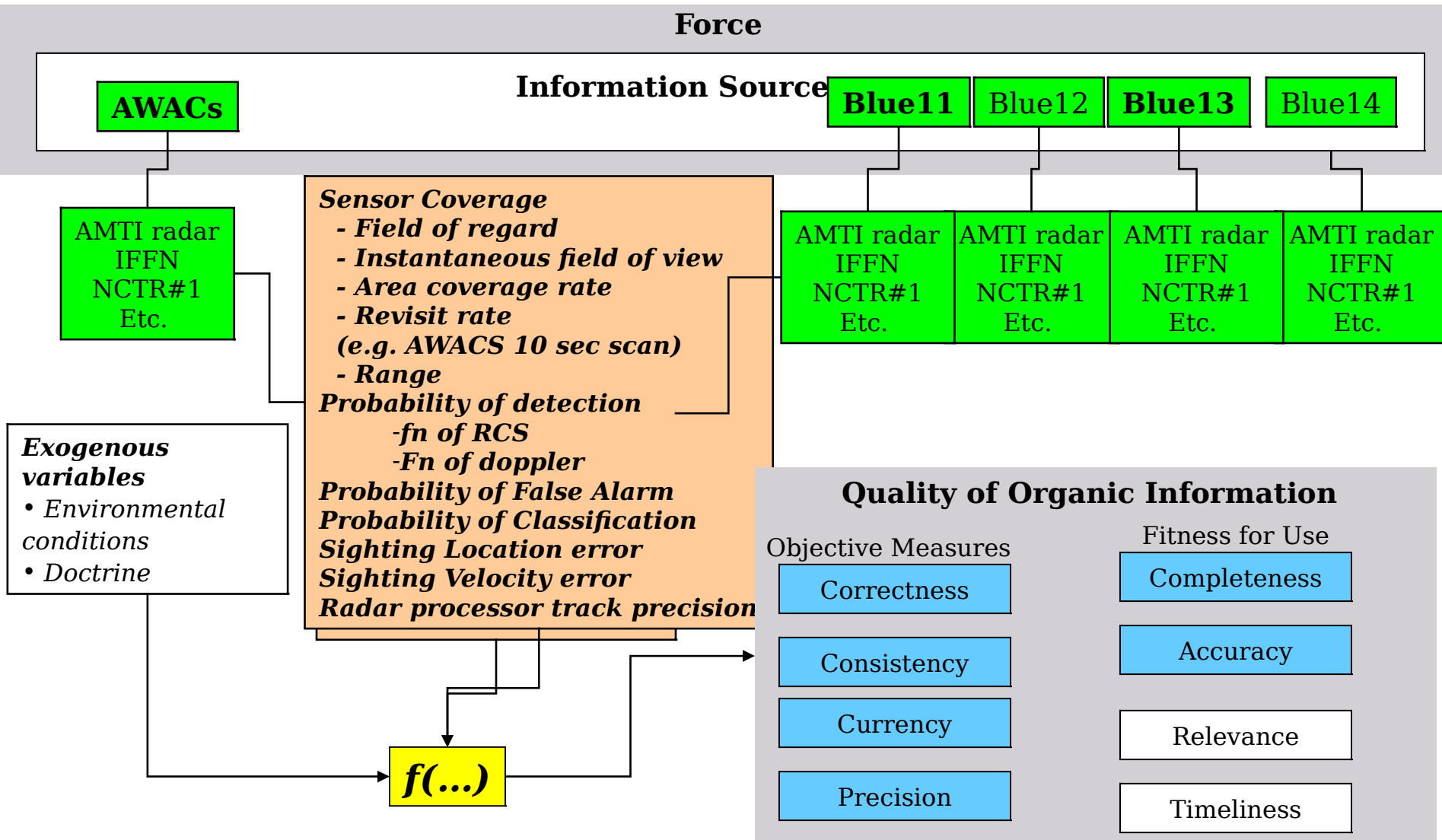
Degree of Information "Share-ability"

Quantity of Posted Info

Quantity of Retrievable Info

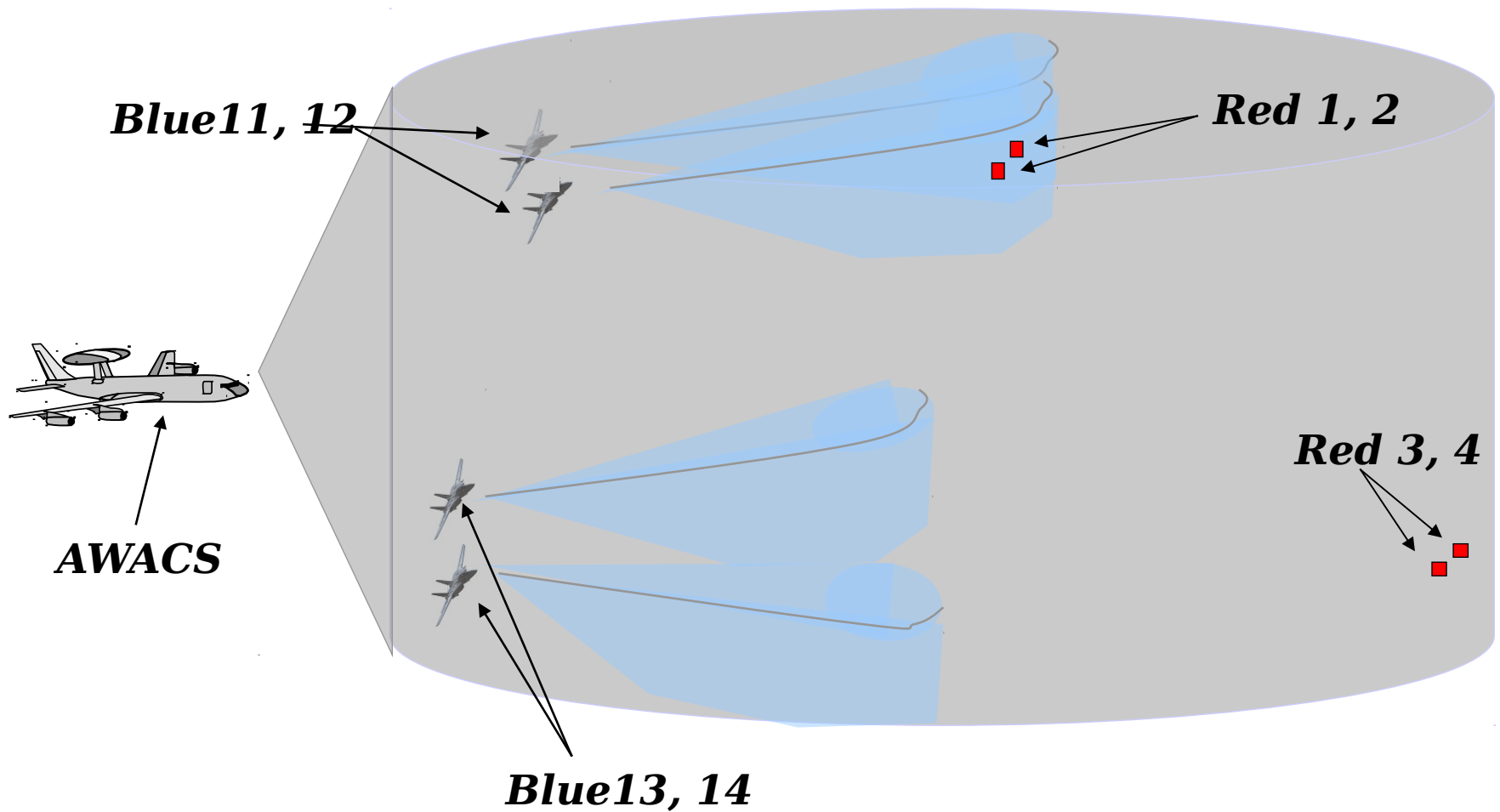
Ease of Use

Computing Quality of Organic Information



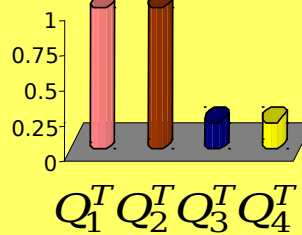
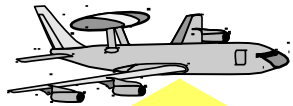
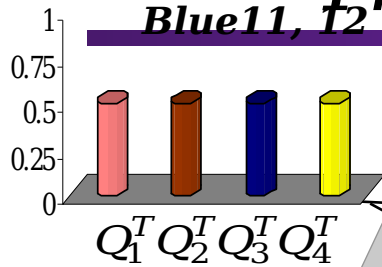
Air-to-Air Scenario Exemplar

Four-on-Four Engagement

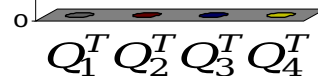


Quality of Organic Information for Threat Tracks (Red 11-14)

Blue11, 12



Blue13, 14



Metric score for a track updated within a given time range (age of report)

Metric	<1 second	1 to 10 seconds	> 10 seconds
Detection or ID	1	1	0
Location or Velocity	1	0.25	0

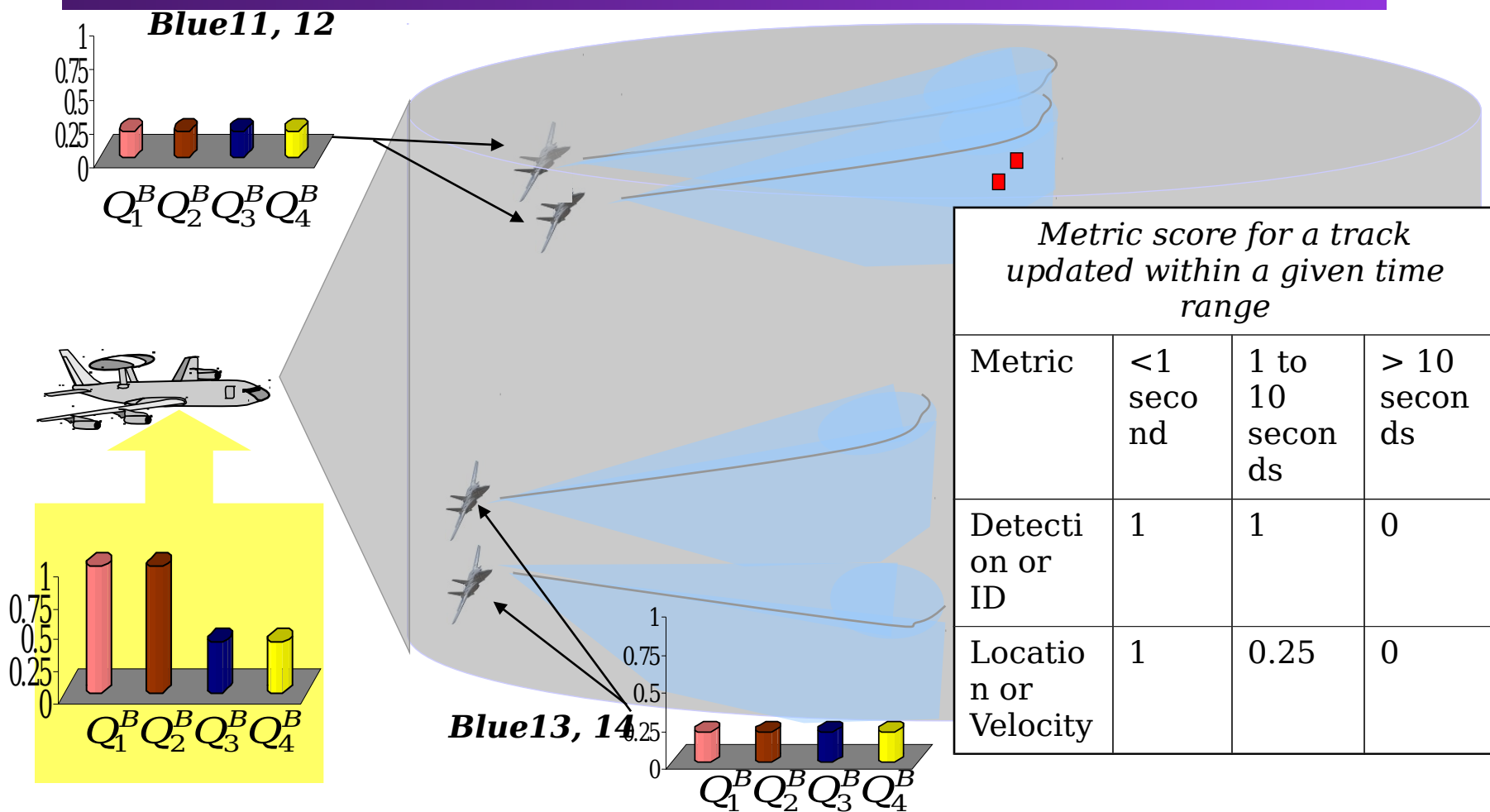
Q_1^T **Completeness: Detection**

Q_3^T **Correctness: Location**

Q_2^T **Correctness: ID**

Q_4^T **Correctness: Velocity**

Quality of Organic Information for Blue Tracks (Blue 11-14, AWACS)



Q_1^B : Completeness: Detection

Q_3^B : Correctness: Location

Q_2^B : Correctness: ID

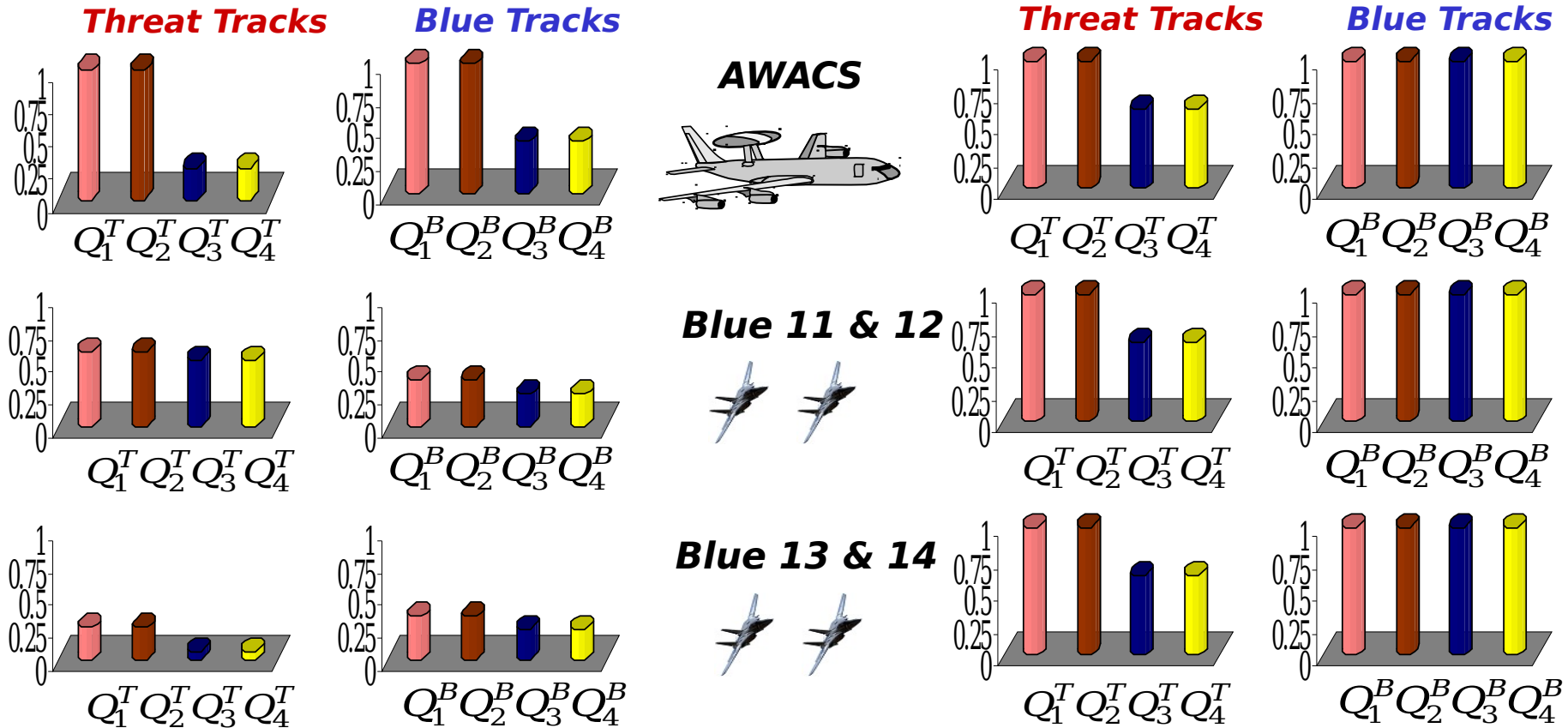
Q_4^B : Correctness: Velocity

Quality of Individual Information

Voice Only vs. Link 16

Voice Only

Link 16 + Voice

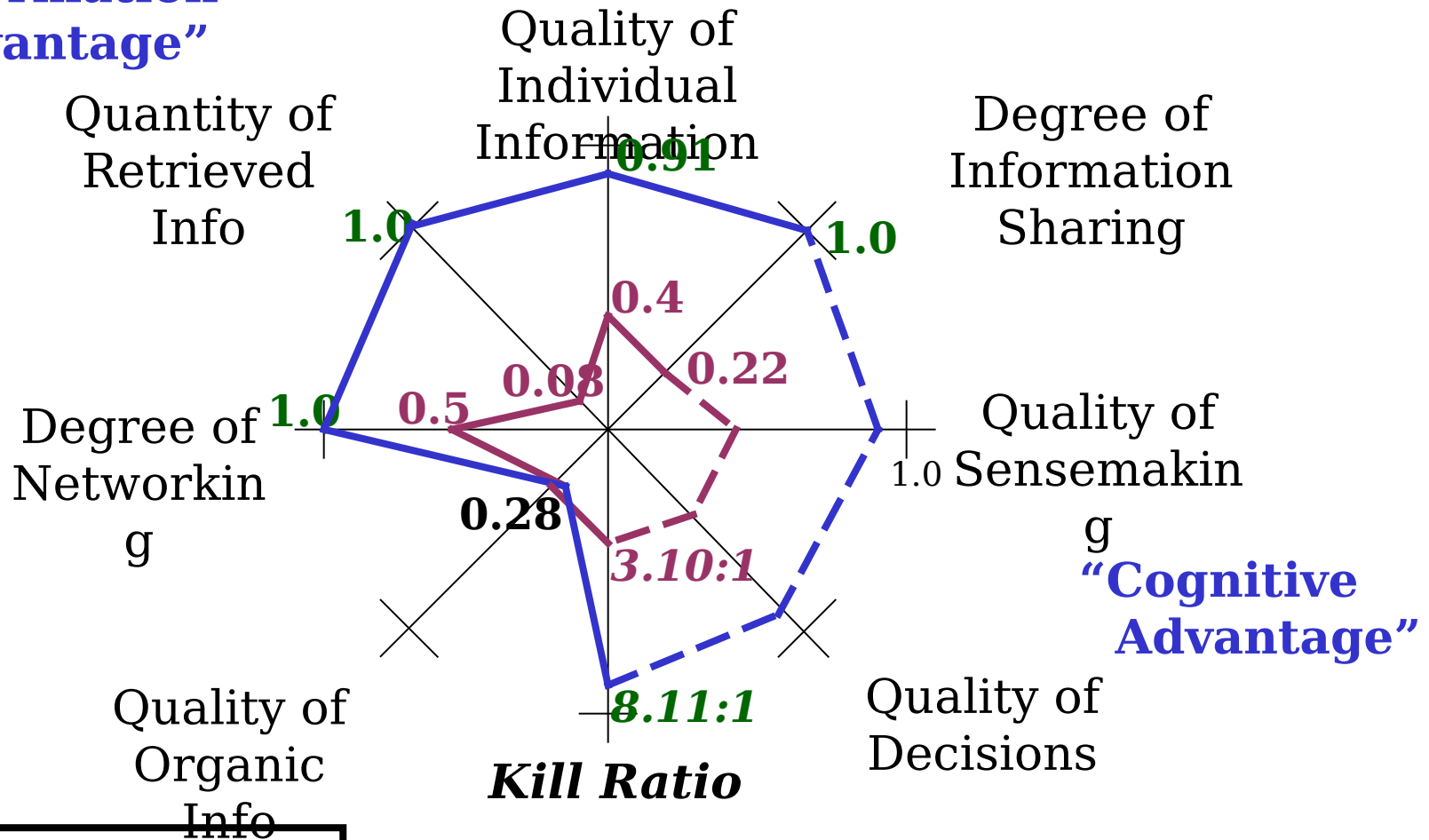


Q_1 **Completeness: Detection**
 Q_2 **Correctness: ID**

Q_3 **Correctness: Location**
 Q_4 **Correctness: Velocity**

Air-to-Air Combat: Value of Information + Cognitive Advantage

**“Information
Advantage”**



—* Voice
—* Voice + Link

**“Warfighting
Advantage”**

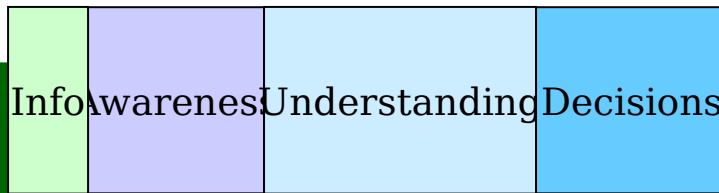
-to-Air Case Study --- Cognitive Advantages of Superior Ability to Observe - Orient - Decide

B11 (Flight Lead)

Voice Only

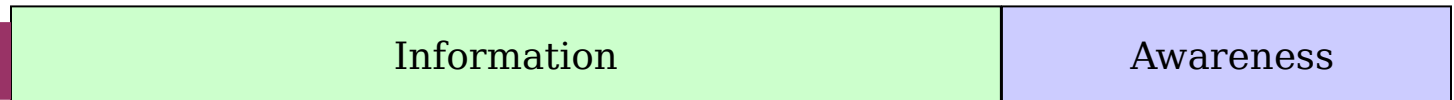


**Link-16
+Voice**

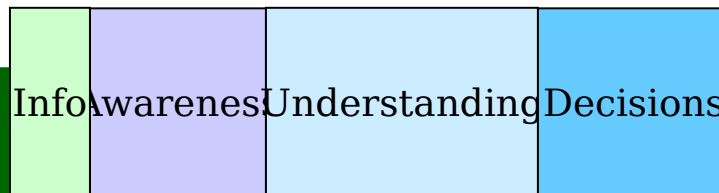


B12 (Wingman)

Voice Only



**Link-16
+Voice**

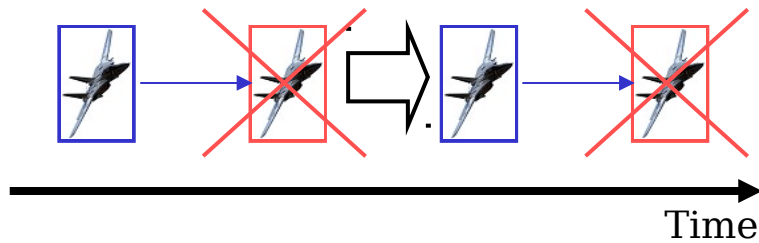


Time
→

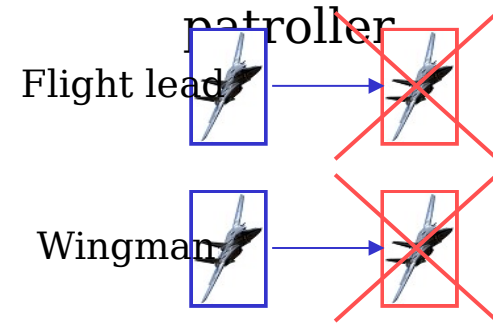
Air-to-Air Case Study Insights: Degree of Synchronization and Effectiveness

Reported Tactical Improvements Enabled by Voice + Link 16

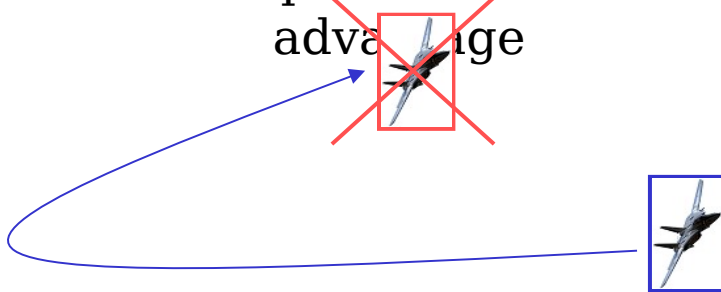
1. Increased numbers of engagements in the same time period



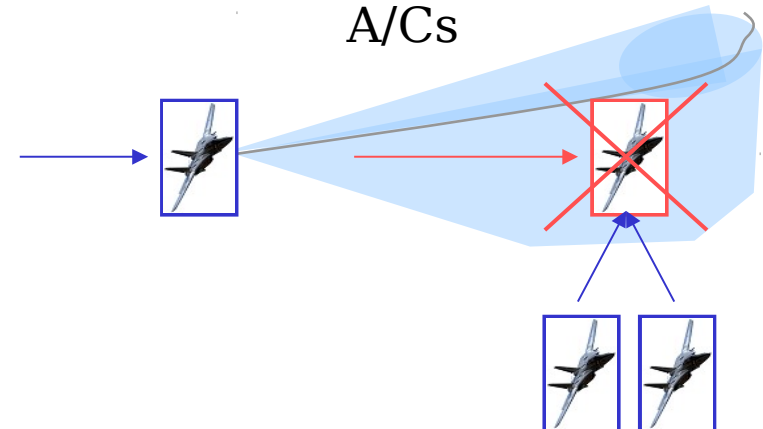
2. Employment of the wingman as combatant rather than defensive



3. Advance vectoring to engage red A/Cs from position of maximum advantage



4. Employment of cooperative formations to trap and destroy red A/Cs



Topic Areas

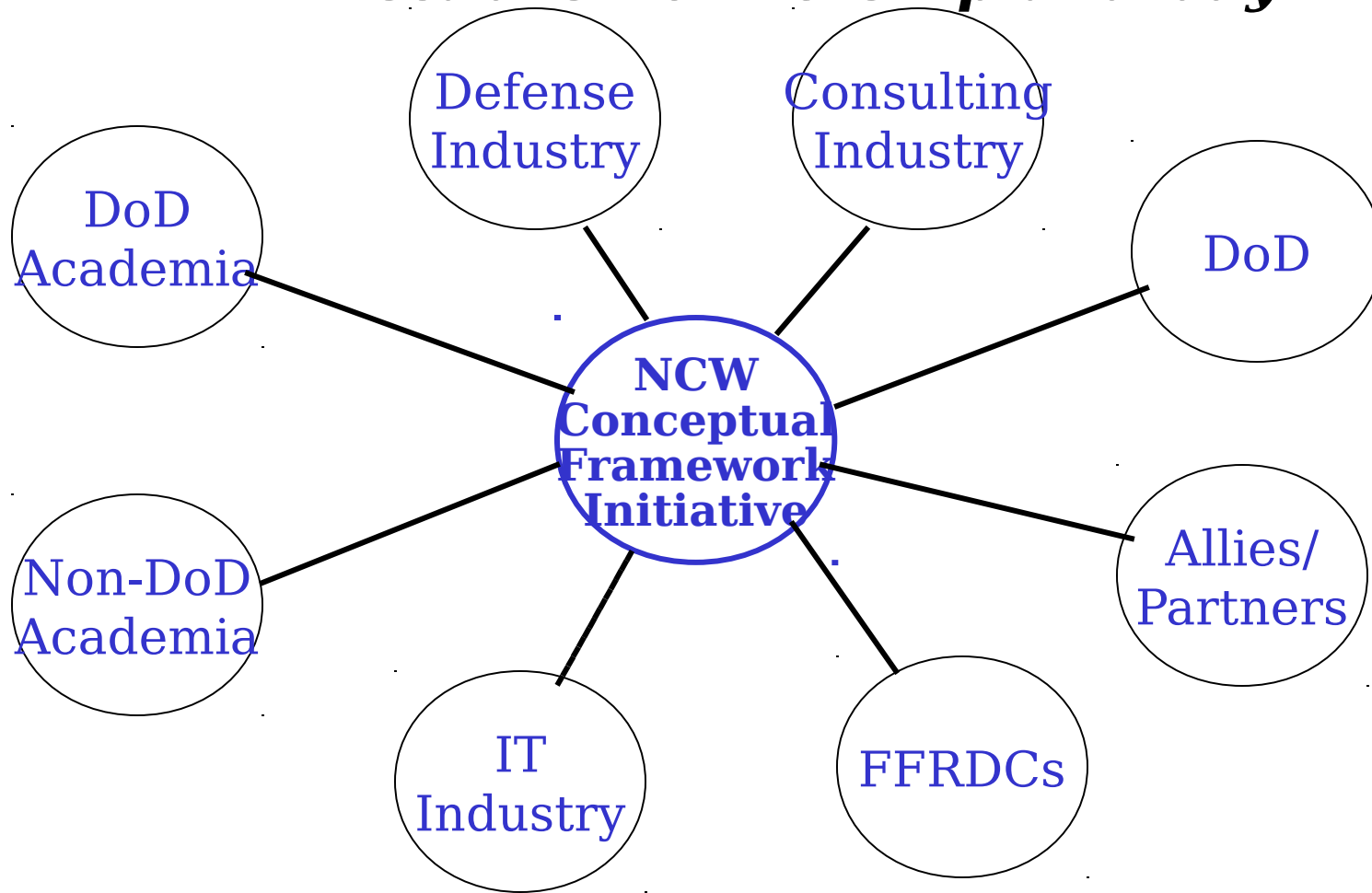
- ***Why a Conceptual Framework (CF)***
- ***The NCW/NCO CF***
- ***Applying the Framework***
- ***Collaboration Opportunities***

Opportunities for Collaboration

- Phase I Complete
 - Significant progress in refining NCW Theory
 - Completed major portion of initial Case Study
- Significant interest in applying Framework
 - Wide range of potential applications
 - Key Allies (UK, Australia) very interested in NCW Conceptual Framework

Opportunities for Collaboration

Establish ownership and buy in



"The ideal environment for cultivating the unknown is well known"
Kevin Kelly - Sep 1997

Case Studies Under Consideration

- **Air**
 - Air-to-Air Mission
- **Ground**
 - DCX Phase I
- **Sea**
 - Collaboration at Sea
 - E-Mail (Info Sharing) and Morale
 - Navy Special Warfare
- **Combined**
 - Air-to-Ground (DCX Phase I, Enduring Freedom, Iraqi Freedom)
- **Joint at the Tactical Level**
 - Maritime Interdiction (FBE Foxtrot)
 - Collaborative Sensing (Network Centric Collaborative Targeting)
 - Misc *Enduring Freedom*
- **Allied/Coalition**
 - Counter SOF (FBE Delta)
 - Peace Keeping/Peace Enforcement (NATO Operation Amber Fox, ISF)
 - ACE Mobile Force (Land) - NATO

Selection Rationale

- Service Diversity
- Across Mission Spectrum
- Varying Degrees of Complexity
- Supports one or more NCW Tenets
- Minimum Requirements:
 - Data Available
 - Cooperative Subject
 - Preliminary Analysis Completed or Underway
 - Can be Started Immediately
- Desirable
 - Partner, co-sponsor, co-funding

NCW Conceptual Framework

QUESTIONS?